Science Benchmark: 06 :01
The appearance of the lighted portion of the moon changesin a predictable cycle as a result of the relative position of Earth, the moon, and the sun.

Standard 01:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.
Objective 1:

Activity 1: It's Just a Phase

Intended Learning Outcomes:
1-Use science process and thinking skills
2-Manifest scientific attitudes and interests
3-Understand science concepts and principles
4-Communicate Effectively Using Science Language and Reasoning

Teacher Background:
The moon rotates on its axis at the same pace as it revolves around Earth. As a result, the moon always keeps the same side pointed toward us throughout its orbit. Astronomers call the side we see from Earth the "nearside of the moon," and the side we never see from Earth the "farside of the moon."

During the moon's cycle, the actual shape of the moon never changes. It is always a sphere. We only see the moon because sunlight reflects back to us from its surface; it has no light source of its own. What changes is the portion of the moon that can be seen from Earth. Half of the moon is always illuminated by the sun. The half of the moon facing the sun is always lighted; but the lighted side does NOT always face Earth. As the moon circles Earth, the amount of its disk facing us that is lighted by the sun changes, altering how much of the lunar surface appears bright and how much is in darkness. The changes are known as phases, and repeat in a specific cycle. These are the primary phases: New Moon, First Quarter, Full Moon, Last Quarter. (It takes 27-30 days to go from one New Moon to the next.)

During the time it takes to move from one phase to another, the amount of the moon's surface lighted by the sun changes gradually; it's not an abrupt change from one phase to the next. (Many times students get the impression that changes are abrupt because they are only shown diagrams of the primary phases.)

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There are times during the cycle when the moon can be seen during the day. These times are predictable. The following chart gives the times when each phase rises and sets.

PHASE	RISES	HIGHEST IN SKY	SETS
New Moon	Sunrise	Noon	Sunset
First Quarter	Noon	Sunset	Midnight
Full Moon	Sunset	Midnight	Sunrise
Last Quarter	Midnight	Sunrise	Noon

Earth's shadow plays no role in the moon's phases, but the shadow of Earth does darken the moon during a lunar eclipse. Earth revolves around the sun once every year. The moon circles Earth about once per month. The plane of the moon's orbit is tilted a little (5°) from the plane of Earth's orbit. When the moon is on the side of Earth away from the sun (Full Moon), it passes very close to Earth's shadow; however, because its orbit is tilted, the moon usually passes just above or below Earth's shadow. About once every six months the moon goes right through the shadow of Earth, creating a lunar eclipse.

Materials:

- phases of the moon cards (see directions at the end of this activity)
- 1 bright lamp without the shade (at least 75 watts)
- Styrofoam ball for each student
- craft (Popsicle) stick, tongue depressor, or sharpened pencil for each student
- observation chart for each student
- lunar diagrams chart
- scissors
- glue or tape

Invitation to Learn:

Ask the students what they see when they look at the moon. As the students describe the various phases, give the appropriate phase card to the student. Teach the correct term for each phase; New, First and Last Quarter, and Full Moon. Include all the phases of the moon but do not name intermediary phases (waxing, waning, gibbous and crescent are not vocabulary words students need to learn). Have the students with the phase cards come to the front of the room. Assign the student to arrange the cards in the order they would see them during the moon's cycle. Start at New Moon and end with New Moon to emphasize that it is a cycle. Have the students tape the cards to the board in the order they have determined. Do not comment or evaluate the order at this time. Students will discover the correct sequence for themselves in the next activity.

Instructional Procedures:

This activity works best in a dark room with a bright light at student eye level.

1. Place the lamp in the middle of the room. Arrange furniture so there is enough room for the students to stand with arms extended in a circle around the lamp.
2. Distribute a Styrofoam ball moon model to each student. Stick a pencil or Popsicle stick into the ball to make it easier to hold.
3. Explain to students that the light represents the sun and their heads will represent Earth. They also need to imagine that all observations are being made by a person standing on the top of "Mt. Nose." Have all the students stand so that it is noon for the observer on Mt. Nose. (This can also be called "noses at noon" position.) Have the students rotate to the position where it is midnight on Mt. Nose (noses at midnight). Have the students rotate in the correct counterclockwise direction. (To help students remember how to rotate, it is helpful to have them put their right hand over their hearts as if saying the Pledge of Allegiance and then use that hand to push themselves around.) Have the students extend their arms to represent the horizons for the observer on Mt. Nose. Allow the students to determine which hand represents the western horizon where the sun sets and which hand represents the eastern sky where the sun rises.
4. The students should hold the Styrofoam ball slightly above their heads to keep it out of their bodies' shadows. Have the students observe the moon in different positions as it rotates around their heads or Earth. Ask them how much of the moon is illuminated as it rotates. Make sure that the students understand that half the moon is always illuminated.
5. Start at New Moon position. Have the students observe that the illuminated side is away from them and the farside is visible. Have the students rotate 1/8 of the way around the circle. They should now be able to see a small crescent of the illuminated side. Have the students rotate another 1/8 of the way around the circle to the point where they see the First Quarter. Continue through the lunar cycle and back to New Moon.
6. Have the students go through the sequence again, this time saying the name of the phases New, First, Quarter, Full and Last Quarter as they pass through each phase.
7. Call out moon phases and have students move to that position. (Make sure that the students move in a counterclockwise direction to correctly model the moon's orbit.)
8. Distribute the Moon Observation Chart to the students. Assign them to observe the moon in the sky each day/night. Students should color the part of the visible circle that is illuminated yellow, and the part that is not illuminated black. Students should describe the appearance of the sky in their journals.

<u>Possible Extensions/Adaptations/Integration:</u>

Extensions:

• Have the students work in pairs with one student holding the moon in the different phases. The

other student should extend his/her arms and rotate to determine the time of day when each phase rises and sets.
- Use the model to demonstrate lunar and solar eclipses.

Adaptations:
This activity can be done using an overhead projector to represent the sun. Have all the students stand opposite the projector.

Integration:
Read and discuss legends about the phases of the moon. Share poetry about the moon and have the students write a moon poem.

Assessment Suggestion:
Distribute Oreo Cookies and a plastic knife to the students. Have the students separate the cookies and use the white frosting to represent the illuminated portion of the moon that we see during each phase. The chocolate cookie represents the portion of the moon that is not illuminated. The cookies could be placed on a calendar on the appropriate days to demonstrate understanding of the cycle. (Teacher will need to provide information on the phase for the day the activity is conducted.)

Given a specific phase, the students will determine what phase they will be able to see in 24 hours, in 72 hours, in 1 week, or in 2 weeks.

Have the students complete the worksheet to show level of individual understanding.

Additional Resources:
Branley, Franklyn M. *The Moon Seems to Change*. 1987.
Simple text, but good photos and drawings about the phases and movement of the moon. $4.50

Estalella, Robert. *Our Satellite: The Moon*. 1994.
General text about the moon, includes phases. Two page chapters, photo on one side, text opposite. 32 pages. $6.95.

Smith, P. Sean. *Project Earth Science Astronomy*. NSTA, Arlington, VA, 1998.
ISBN 0-87355-108-7

Sneider, C. I. *Earth, moon, and Stars*. Lawrence Hall of Science, Berkeley, CA, 1986.
The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook.

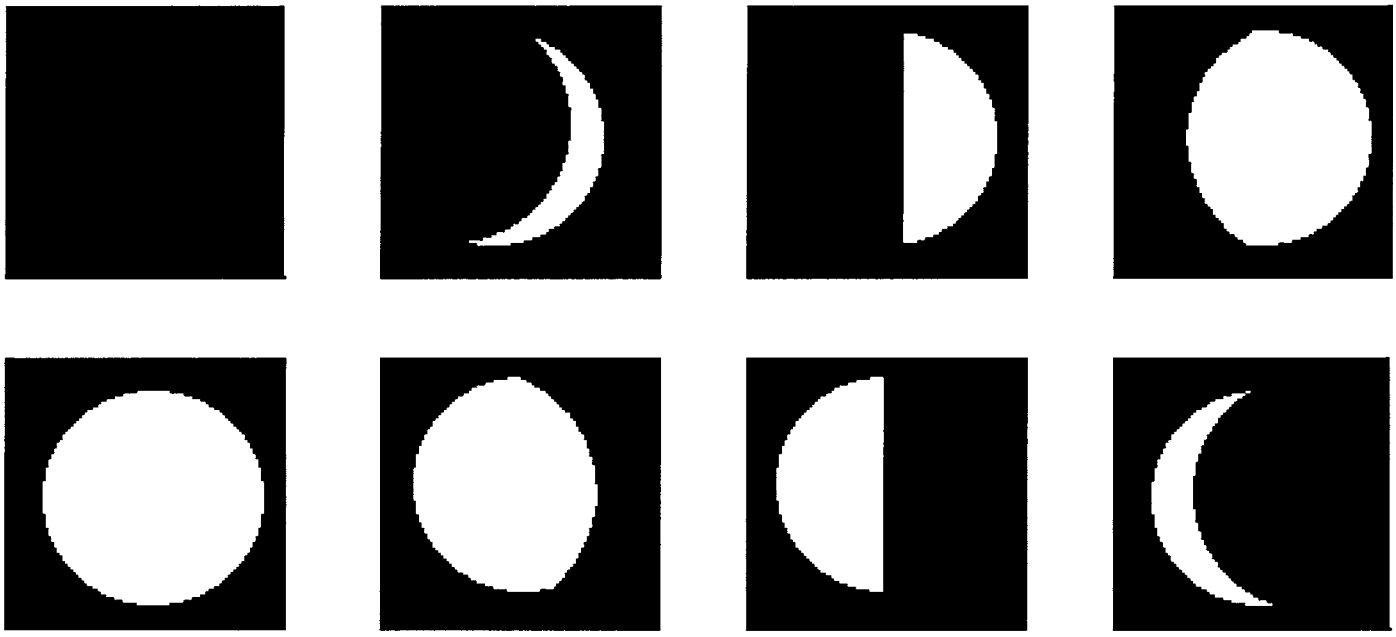
Astronomical Society of the Pacific, San Francisco, CA, 1995.
ISBN 1-886733-00-7

Exploration (allows students to view moon phase for any day of their choosing)

http://liftoff.msfc.nasa.gov/Academy/UNIVERSE/MOON.HTML

Phases of the moon: 2001 - 2100
http://sunearth.gsfc.nasa.gov/eclipse/phase/phases.2001-2100.html

Directions for Moon Phase Cards



Enlarge the drawings above to fit on 9” by 9” construction paper to make moon phase cards. Laminating will increase their life span.

Moon Record Chart

Sun	Mon	Tue	Wed	Thurs	Fri	Sat
Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______
Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______
Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______
Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______	Date ______ Time ______

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Standard 01:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.
Objective 1:
Explain patterns of changes in the appearance of the moon as it orbits Earth.

Activity 2: Phases of the Moon

Intended Learning Outcomes:
1-Use science process and thinking skills
2-Manifest Scientific Attitudes and Interests
3-Understand Science Concepts and Principles
4-Communicate effectively using science language and reasoning
6-Understand the nature of science

Teacher Background:
The moon orbits around Earth once every 27-30 days. During this time, the moon moves eastward about 13° per day (just bigger than a fist at arm's length), making the time of moonrise later each day. From Earth, we see it as the moon changing position in the sky and changing the percent of the illuminated side we are able to see (called phases). At any given time, half of the moon has sunlight hitting it (the day side of the moon) and the half not facing the sun is dark. How much of the illuminated side of the sun we can see from Earth determines the phase of the moon. The basic phases are New, First Quarter, Full, Last Quarter, and back to New. First Quarter occurs and we continue to see more of the moon until we can see the entire illuminated side at Full Moon. The phases move to Last Quarter, and then the New Moon and we begin the cycle all over again. As the moon orbits around Earth, it also rotates on its axis. We only see one side of the moon because it keeps the same side facing Earth. If it didn't rotate as it orbited Earth, we would see both sides of the moon. The side we see from Earth is the "nearside of the moon" and the side we never see from Earth is the "farside of the moon."

Materials:
- phase sheet for each student (2 are included - teacher select)
- glue
- paper
- the moon as seen from Earth model.

Invitation to Learn:

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Give the students phase sheets and have them cut out the moons pictured along the bottom. Next they should glue the pictures into the boxes in the location they think is correct.

Instructional Procedures:

This activity will take at least two weeks and must begin in the evenings beginning a day or so after the New Moon.

1. Have the students pick a spot in their backyards or near their houses where they can observe the moon at the *same time* each evening.
2. Students will draw the foreground objects they see from their observation spot on a piece of paper.
3. A quick sketch of what the moon looks like and where it is each night will be drawn in comparison to the foreground objects (house, garage, tall tree, power pole, etc.) on the same paper. Students can use their fists to estimate angles and aid in their placement of the moon.
4. Following the 2-week evening observations, teachers can also do one week of day time observing with the entire class a few days after the Full Moon. This will help reinforce the fact that the moon is not always seen in the evening and is orbiting around the Earth.

Possible Extensions/Adaptations/Integration:

Assessment Suggestion:

Have students draw a moon, as seen from Earth, to test their understanding.

Additional Resources:

To find when the next New Moon will occur, go to the Hansen Planetarium website http:// www.hansenplanetarium.org education page. Follow the links for the "2002 CORE ACADEMY."

After 2003, you will find this information at http://www.clarkplanetarium.org on the education page.

www.askjeeves/phases of the moon

This site will show you what the moon looks like presently and on any given date in the past and future. There are also schedules of the dates and times the moon rises in any certain city around the world.

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Objective 2:
Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

Activity 3: Wobbling in Circles

Intended Learning Outcomes:
1-Use science process and thinking skills
3-Understand science concepts and principles
6-Understand the nature of science

Teacher Background:
The rotation of an object is when it spins on its axis. The revolution of an object is when it circles around another object. Earth takes about 24 hours to complete one rotation. Earth takes 365 1/4 days to make a complete revolution. It takes the moon about 27-30 days to make one revolution, and the same amount of time to make one complete rotation. Therefore, the same side of the moon is always facing Earth. The revolution of the moon around Earth is the reason we have moon phases.

Materials:
- word cards for Earth, moon, sun, planet, and stars (2)
- large open area

Invitation to Learn:
1. Ask students if they know the difference between a rotation and a revolution.
2. Have a student demonstrate the counter clockwise rotation of Earth.
3. Have another student demonstrate the counter clockwise rotation of the moon while it revolves around Earth. The first student (Earth) should still be rotating. Make sure the moon is only rotating once for every revolution. The same side of the moon should always be facing Earth. Explain to students that the revolution of the moon around Earth is why we have moon phases.

Instructional Procedures:

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1. Explain to the students that Earth revolves around the sun, just as the moon revolves around Earth.
2. Remind students that Earth and the moon rotate counter clockwise as they orbit the sun. The moon revolves around Earth as Earth is revolving around the sun.
3. Assign three students to represent Earth, the moon, and the sun. They should hold the right word cards.
4. Have students demonstrate the rotation and revolution of Earth and the moon around the sun for the class. Make sure they rotate as they revolve.
5. Put students into groups to repeat this activity. Have students play the different roles of the sun, the moon, and Earth.
6. Bring the students back together as a class.
7. Assign students again to be the sun, the moon, and Earth, but this time add two stars and one planet out in the distance.
8. Have Earth slowly turn from day to night. Have them pay special attention to the planet and stars. What do they appear to do? Earth should notice that the planet and stars appear to move across the sky as they are rotating. Point out that although the other planets are revolving around the sun, it is because of Earth's rotation that the planets appear to move across the sky. The same is true with the stars in the sky – they appear to move because of Earth's rotation.
9. Again, break students into groups to repeat the activity so all can understand that stars and planets appear to move across the sky based on earth's rotation. Each student should have the opportunity to play Earth.

Possible Extensions/Adaptations/Integration:

Assessment Suggestions:

1. Observe groups demonstrating the activity to make sure the concepts are understood.
2. Journal Activity: Have students write a paragraph comparing a revolution and a rotation. Have them explain the movement of Earth and the moon in space, in addition to the apparent change in position of the planets and stars.

Additional Resources: